executed by processor **12**. Memory **20** may also be located internal to processor **12**, or any combination of internal and external memory.

[0016] Touchscreen **11** recognizes touches, and may also recognize the position and magnitude of touches on a touch sensitive surface. The data corresponding to the touches is sent to processor **12**, or another processor within telephone **10**, and processor **12** interprets the touches and in response generates haptic effects. Touchscreen **11** may sense touches using any sensing technology, including capacitive sensing, resistive sensing, surface acoustic wave sensing, pressure sensing, optical sensing, etc. Touchscreen **11** may sense multi-touch contacts and may be capable of distinguishing multiple touches that occur at the same time. Touchscreen **11** may further display images for the user to interact with, such as keys, dials, etc., or may be a touchpad with minimal or no images.

[0017] Although the embodiment of FIG. **1** is a cellular telephone **10**, other embodiments may be any type of device that provides a user interface and is capable of generating haptic effects. The device may be handheld and may include a touchscreen that generates the user interface. In other embodiments, rather than generating haptic effects on a handheld device for touchscreen interactions, the device may be a computer system that includes a display and a cursor control device such as a mouse, touchpad, mini-joystick, etc. The display displays the user interface and the mouse or other device includes vibration actuator **18** so that the haptic effect is generated on the device as it is held by the user.

[0018] FIG. **2** is a block diagram of a user interface ("UI") **200** that includes a list of elements **202** that can be scrolled through the interaction of a scroll bar **204** in accordance with one embodiment. A user can slide scroll bar **204** through interaction with a touchscreen, or by pressing a button or using a mouse or other interface device. Further, arrows **206** can be selected in a known manner to scroll the list of elements **202**.

[0019] When elements **202** are being scrolled, one of the elements is highlighted to indicate which element is "selected". In one embodiment, a haptic effect is generated when each element of elements **202** is selected. The haptic effect may be in the form of a "bump" "pop", "click", "tick", etc. through a predetermined combination of magnitude, frequency and duration. However, as the scroll rate is increased, a constant magnitude haptic effect can feel like a constant "buzz" to the user and fail to provide meaningful information. Therefore, in one embodiment, the haptic effect volume/magnitude is decreased as the scroll rate increases, and vice versa. This keeps the overall "haptic energy" of the UI interaction at a low and unobtrusive level.

[0020] FIG. **3** is a flow diagram of the functionality performed by telephone **10** of FIG. **1** in accordance with one embodiment in response to a scrolling of elements **202** through a user interface. In one embodiment, the functionality of FIG. **3**, and FIGS. **4** and **6** below, is implemented by software stored in memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

[0021] At **302**, an indication that the user is scrolling through the list of elements **202** and one of the elements has been highlighted or selected is received. In one embodiment, the list of elements **202** can be a literal list such as a menu list or list of contacts as in FIG. **2**, or it could be an abstract list such as a 3D cylinder clock with a list of scrolling digital numbers that can be changed by scroll/flick tumbling of numbers. The scrolling may be accomplished by interacting with the screen through a touchscreen, by button press/hold events in up/down, left/right, diagonal or circular motion, or by any other method.

[0022] At **304**, the current scroll rate of elements **202** is determined and may be compared to a previous scroll rate. It is determined if the current scroll rate is increasing or decreasing.

[0023] At **306**, a haptic effect that corresponds to the selection of one of the elements is generated based on the current scroll rate and whether it is increasing or decreasing or based on the magnitude of the scroll rate. In one embodiment, the haptic effect has a short duration and repeats whenever a new element is selected. The magnitude of the haptic effect is decreased relative to a previous haptic effect if the scroll rate is increasing. Similarly, the magnitude of the haptic effect is increased relative to a previous haptic effect if the scroll rate is decreasing. In another embodiment, the magnitude of the haptic effect is determined from a lookup table that bases the magnitude inversely on the current scroll rate. The greater the scroll rate, the smaller the magnitude, and vice versa.

[0024] In one embodiment, when a user is scrolling the list of elements **202**, eventually the user will reach the end of the list. At the point, the scrolling may stop or the list may wrap around to the beginning of the list. In one embodiment, a haptic effect will be generated when the last item in the list is selected or when the list wraps around so that a user receives a non-visual indication. This haptic effect is different than the haptic effect that is generated when one of the items is selected that is not at the end of the list, as disclosed above. In one embodiment, the end-of-list haptic effect differs via a change in any combination of duration, amplitude, frequency, etc.

[0025] In another embodiment, a list of items or other objects, such a photos, a ball, puck, etc. can be "flicked" using a gesture so that the list visually moves. The speed of the movement can be dependent on the speed of the flick. Upon hitting a virtual stop, like an end-of-list, wail or other "hard object," the flicked object reacts visually with a bounce. In one embodiment, the bounce causes a corresponding haptic effect and optionally an audible output. In one embodiment, the haptic effect would have characteristic parameters of being initially very strong (i.e., high magnitude) with a rapidly decreasing magnitude as the bounced object comes to rest. Further, another haptic effect may be generated, such as a subtle haptic click, pop, or tick effect to confirm that the flicked object has stopped moving and come to rest.

[0026] FIG. **4** is a flow diagram of the functionality performed by telephone **10** of FIG. **1** in accordance with one embodiment in response to a flicked object. At **402**, processor **12** receives an indication that a flicked object has reached an end point, such as a wall, end-of-list, etc. At **404**, in response to the end point indication, a haptic effect is generated. In one embodiment, the haptic effect is dynamic in that it initially has a high magnitude, and then has a rapidly decreasing magnitude as the flicked object comes to rest.

[0027] In another embodiment, a user interface simulates a slider. There are a number of physical control sliders found in professional audio and industrial control equipment. These sliders are generally controlled by dragging the slider with a fingertip. Many of the slider control functionality can be built into touchscreen UIs. FIG. **5** is a UI **500** for a touchscreen that provides a virtual slider **502** for controlling volume. UI **500**